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Carletti

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(54) **GROUND FAULT DETECTION**

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G01R 1/20 (2006.01)
G01R 23/02 (2006.01)

(52) **U.S. Cl.**
CPC ***G01R 31/025*** (2013.01); ***G01R 1/20*** (2013.01); ***G01R 23/02*** (2013.01)

(58) **Field of Classification Search**
USPC 324/509, 503, 415, 424, 529, 536, 537, 324/600, 691, 750.3, 76.11, 76.12; 361/42, 361/45, 1, 111, 18, 2, 93.1; 700/293, 58; 702/58
See application file for complete search history.

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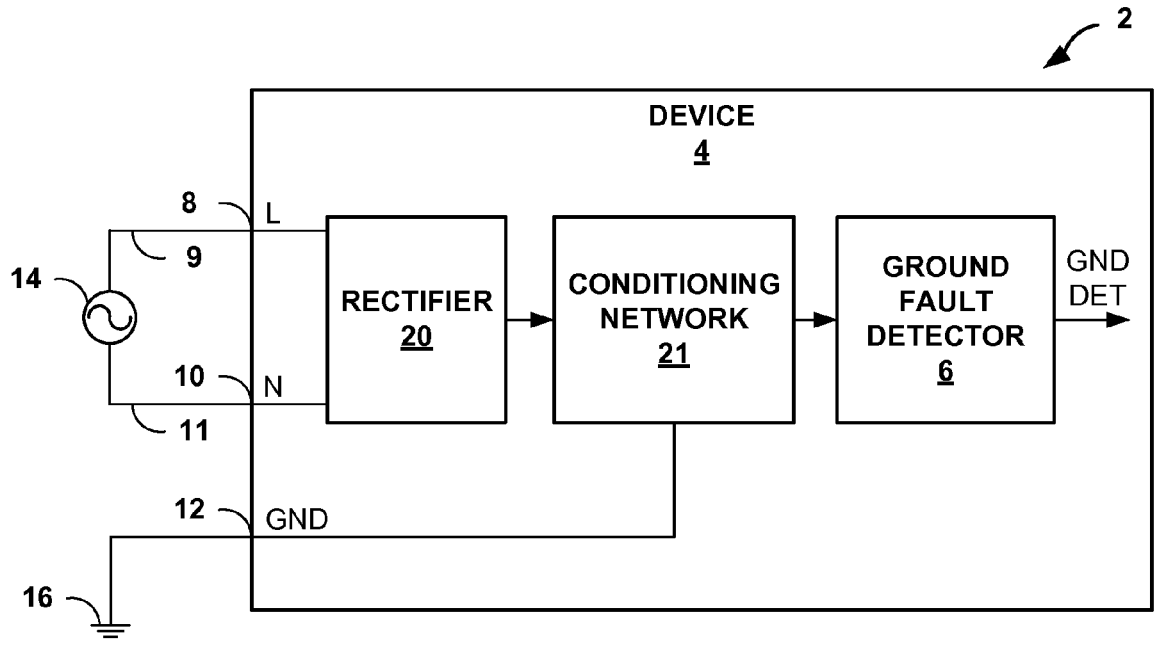
(57) **ABSTRACT**

In one example, a method includes receiving, at an input of a system, an AC signal, rectifying the AC signal into a DC signal, and determining, based on a value of one or more counters in a detection logic, whether or not the input is connected to ground.

21 Claims, 9 Drawing Sheets



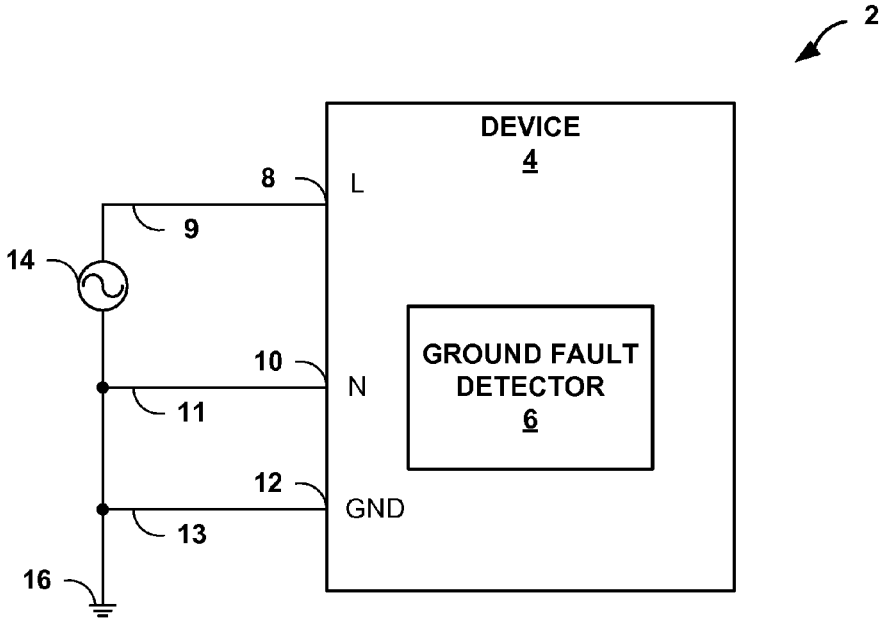

2
DEVICE
4
8
L
9
14
10
N
11
GROUND FAULT
DETECTOR
6
12
GND
13
16

FIG. 1A

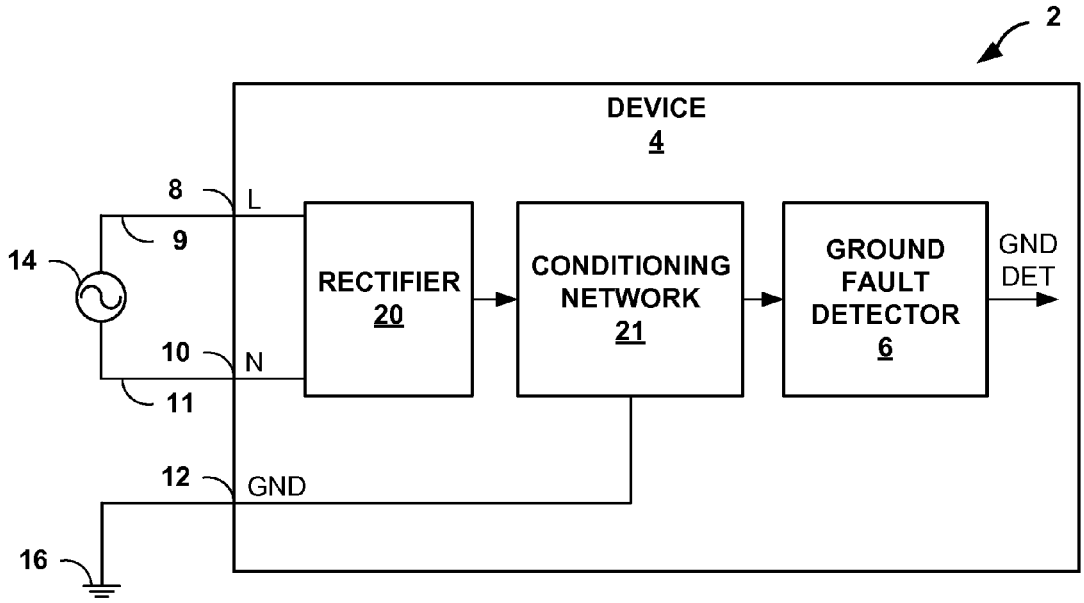

2
DEVICE
4
8
L
9
14
RECTIFIER
20
CONDITIONING
NETWORK
21
GROUND
FAULT
DETECTOR
6
GND
DET
10
N
11
12
GND
16

FIG. 1B

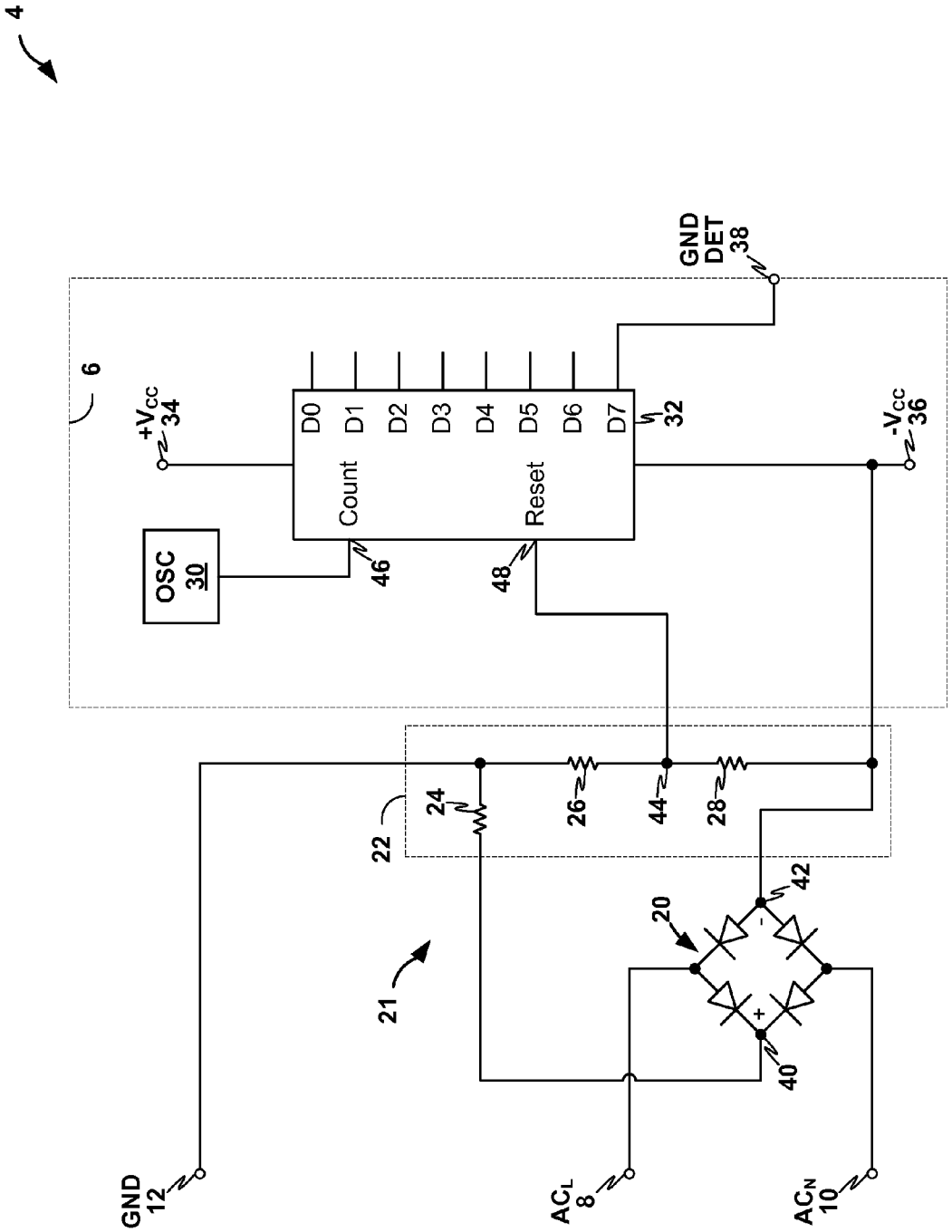

4
6
GND DET 38
+Vcc 34
-Vcc 36
D0
D1
D2
D3
D4
D5
D6
D7
32
Count
Reset
OSC 30
46
48
22
24
26
44
28
42
20
21
40
GND 12
AC_L 8
AC_N 10

FIG. 2A

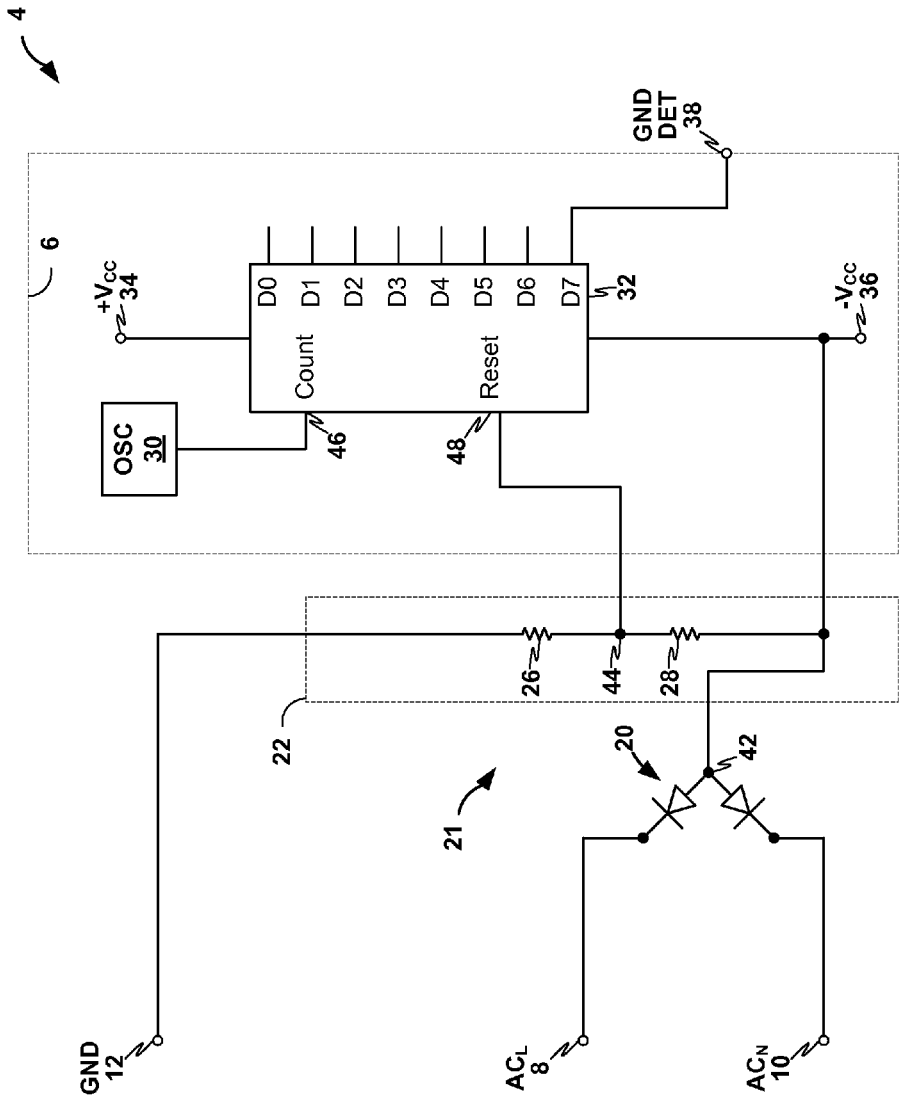

4
6
GND DET 38
+Vcc 34
D0
D1
D2
D3
D4
D5
D6
D7
32
-Vcc 36
Count
Reset
OSC 30
46
48
26
44
28
22
21
20
42
GND 12
ACL 8
ACN 10

FIG. 2B

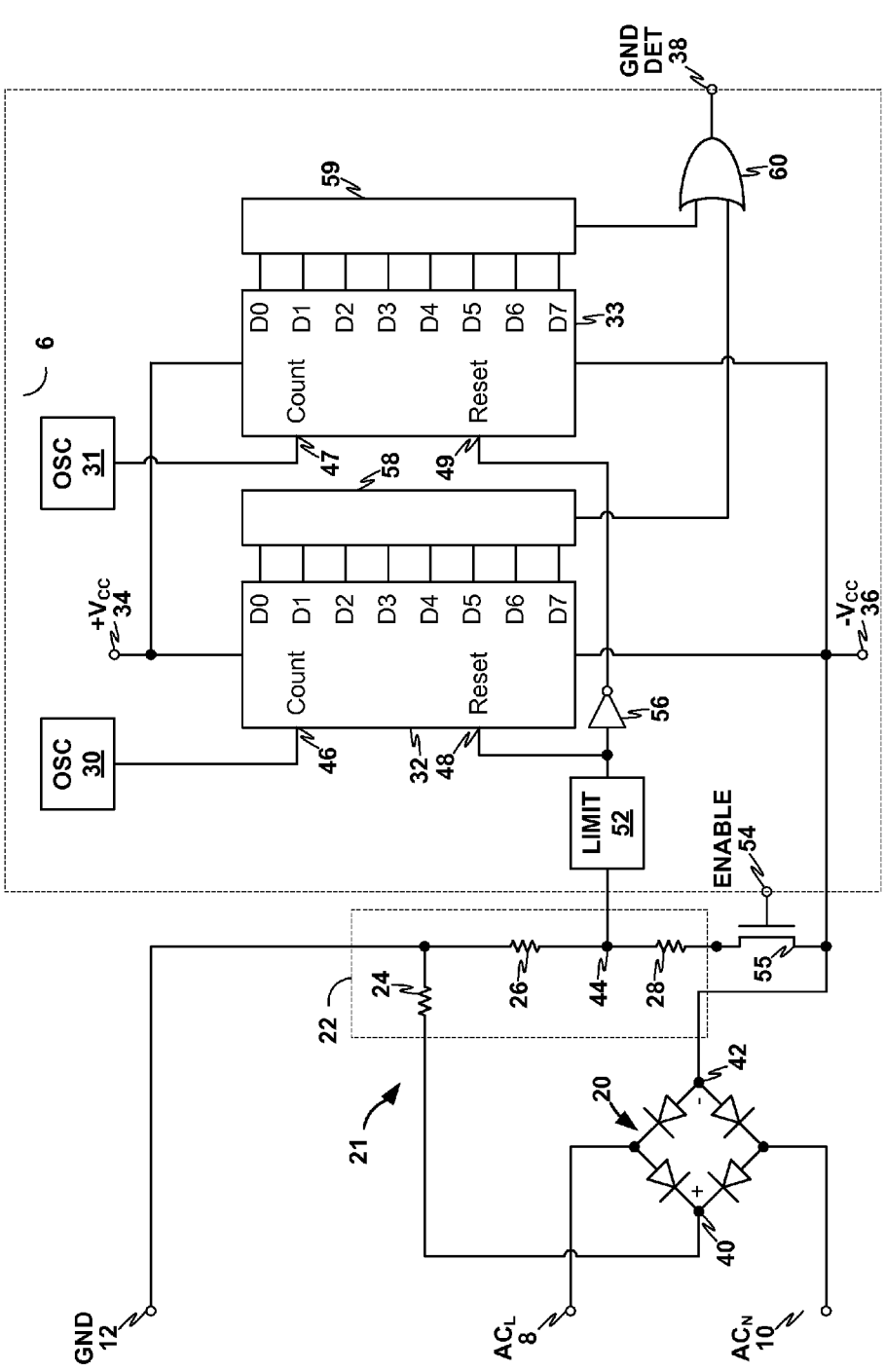

4
GND DET 38
60
59
D0 D1 D2 D3 D4 D5 D6 D7
33
6
Count
Reset
OSC 31
47
58
49
+Vcc 34
-Vcc 36
OSC 30
46
32
48
56
LIMIT 52
ENABLE 54
55
22
24
26
44
28
42
20
21
40
GND 12
AC_L 8
AC_N 10

FIG. 3

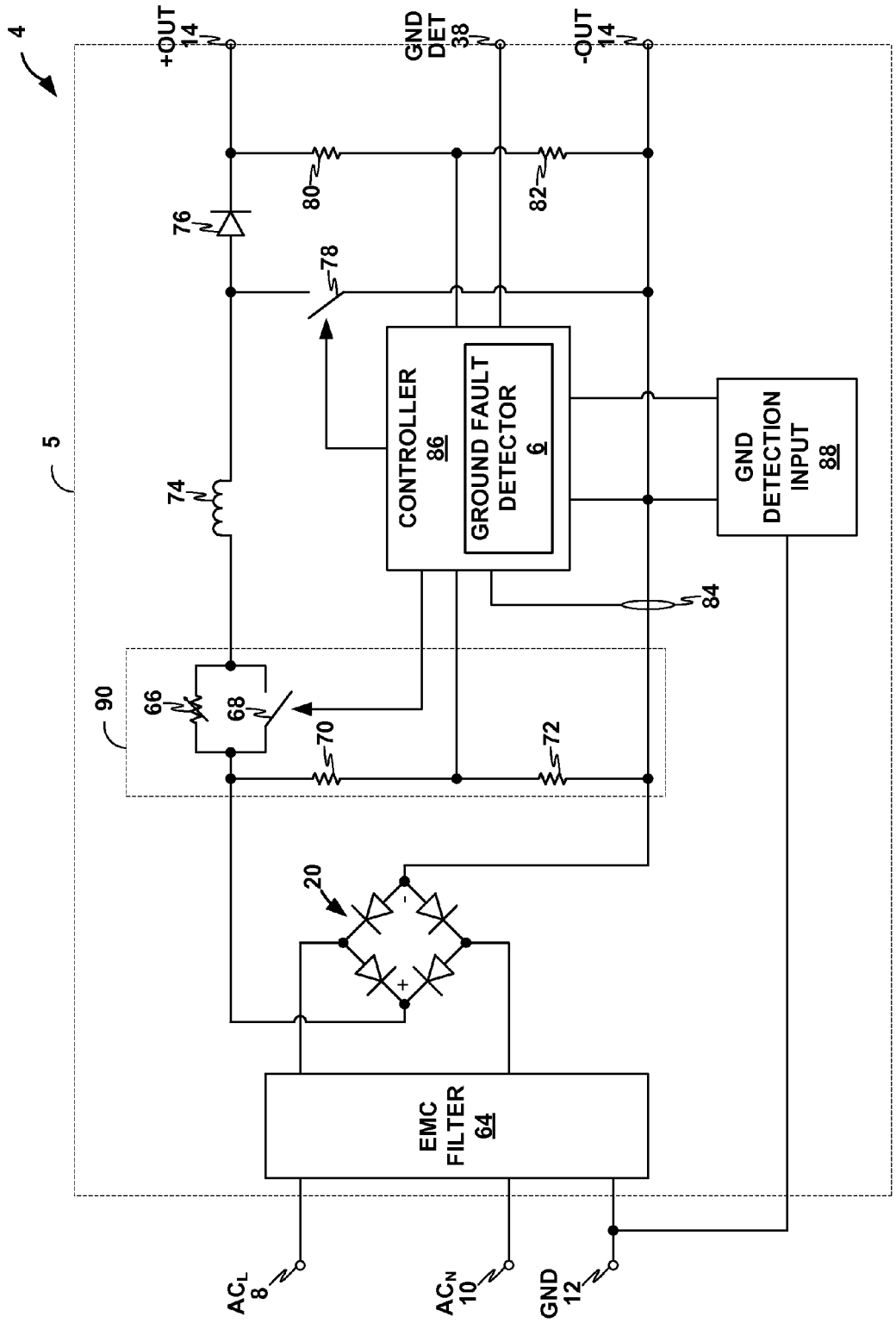

4
+OUT 14
GND DET 38
-OUT 14
80
82
76
78
5
74
CONTROLLER 86
GROUND FAULT DETECTOR 6
GND DETECTION INPUT 88
84
90
66
68
70
72
20
EMC FILTER 64
AC_L 8
AC_N 10
GND 12

FIG. 4

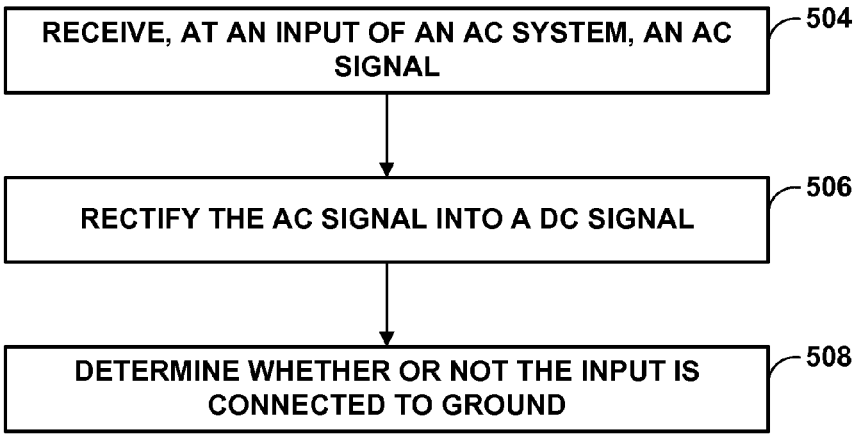

RECEIVE, AT AN INPUT OF AN AC SYSTEM, AN AC SIGNAL
504
RECTIFY THE AC SIGNAL INTO A DC SIGNAL
506
DETERMINE WHETHER OR NOT THE INPUT IS CONNECTED TO GROUND
508

FIG. 5A

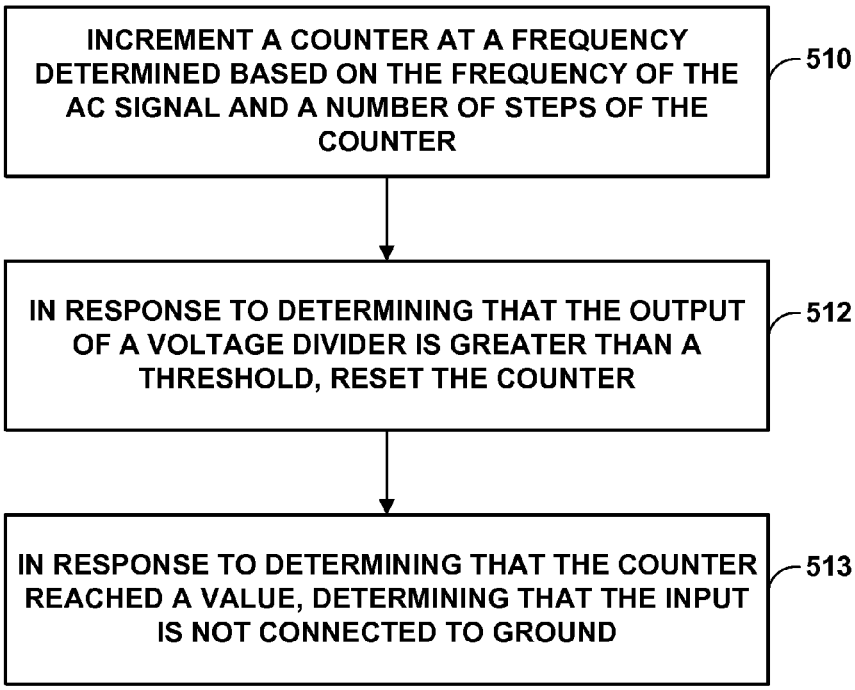

INCREMENT A COUNTER AT A FREQUENCY DETERMINED BASED ON THE FREQUENCY OF THE AC SIGNAL AND A NUMBER OF STEPS OF THE COUNTER
510
IN RESPONSE TO DETERMINING THAT THE OUTPUT OF A VOLTAGE DIVIDER IS GREATER THAN A THRESHOLD, RESET THE COUNTER
512
IN RESPONSE TO DETERMINING THAT THE COUNTER REACHED A VALUE, DETERMINING THAT THE INPUT IS NOT CONNECTED TO GROUND
513

FIG. 5B

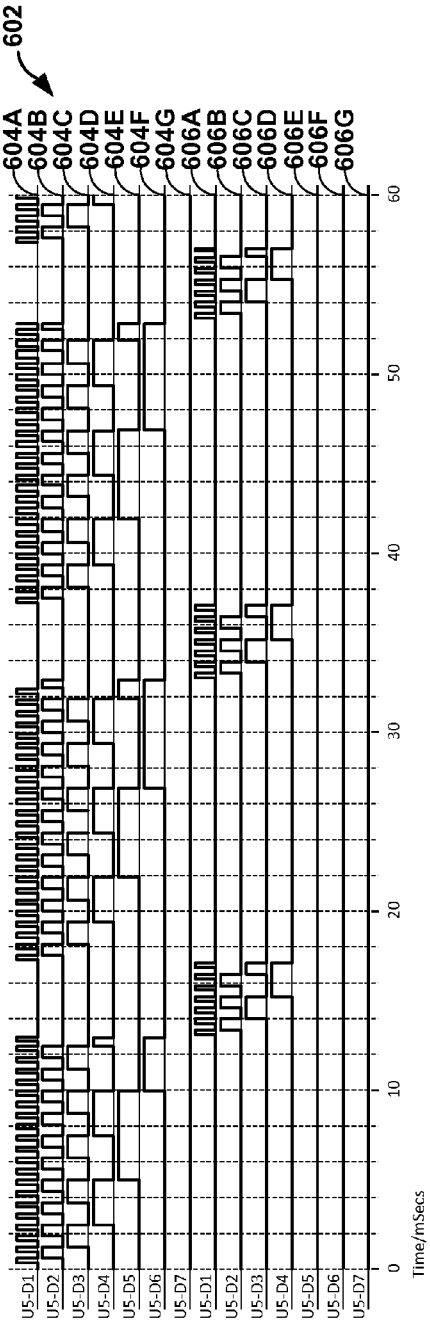


FIG. 6A

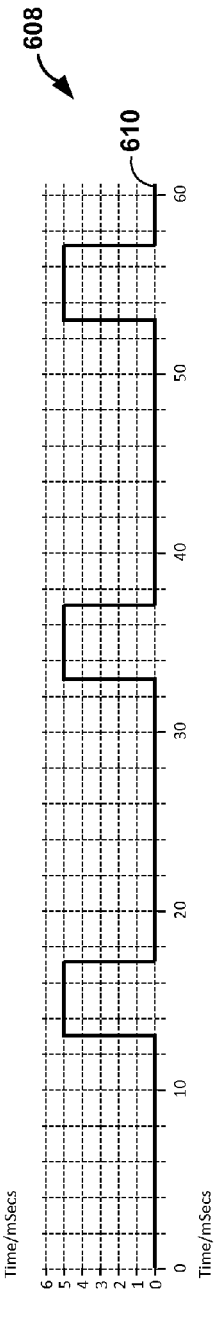


FIG. 6B

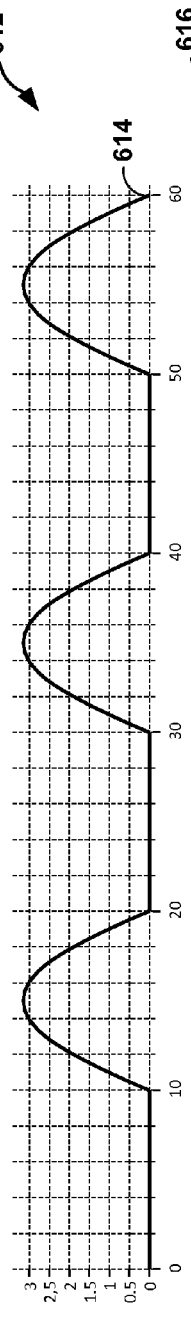


FIG. 6C

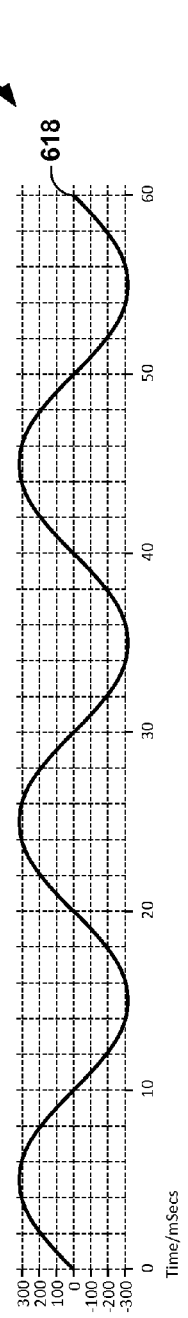


FIG. 6D

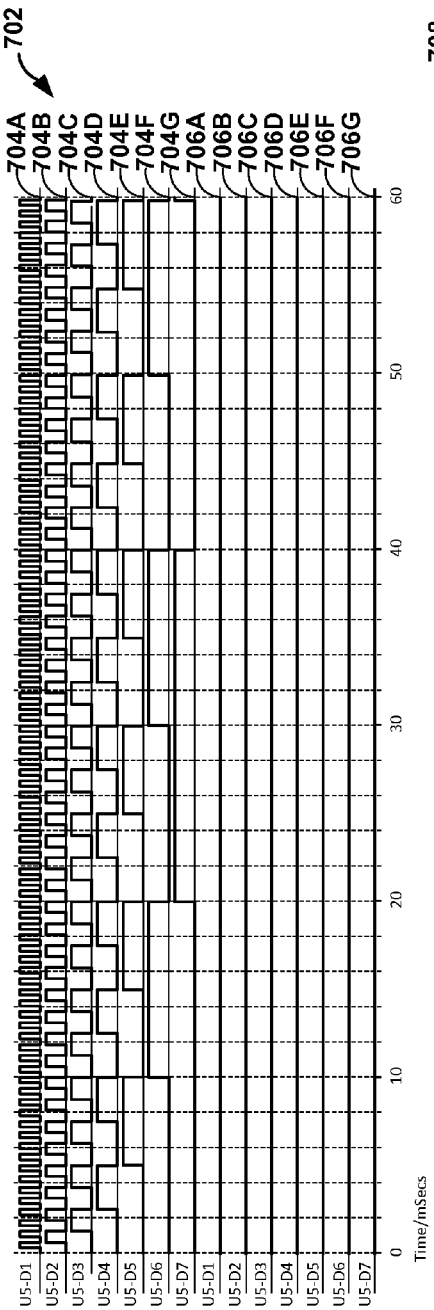


FIG. 7A

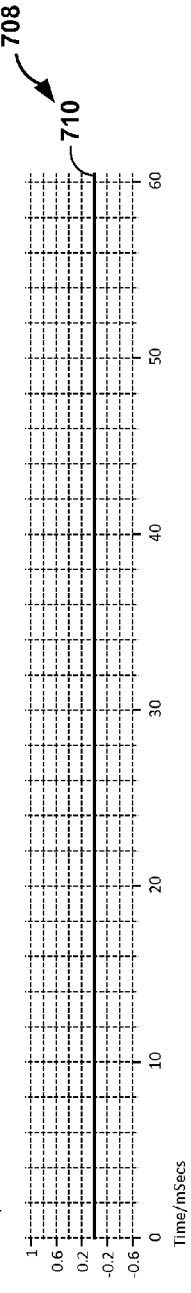


FIG. 7B

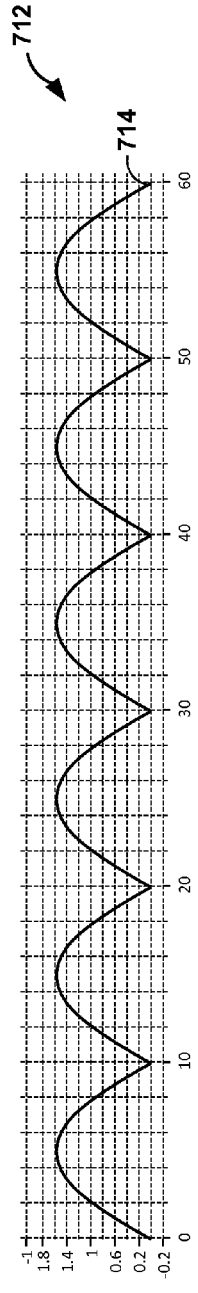


FIG. 7C

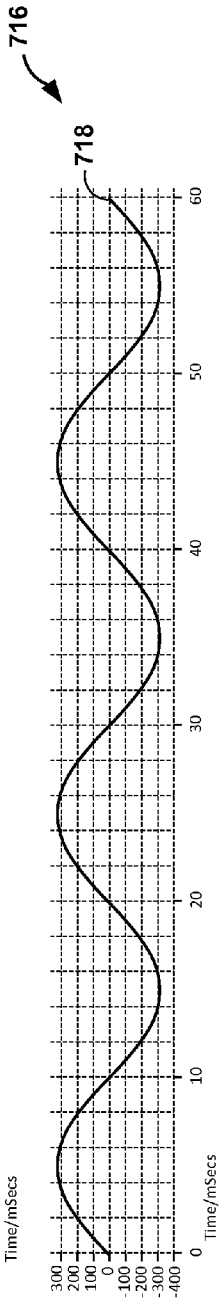


FIG. 7D

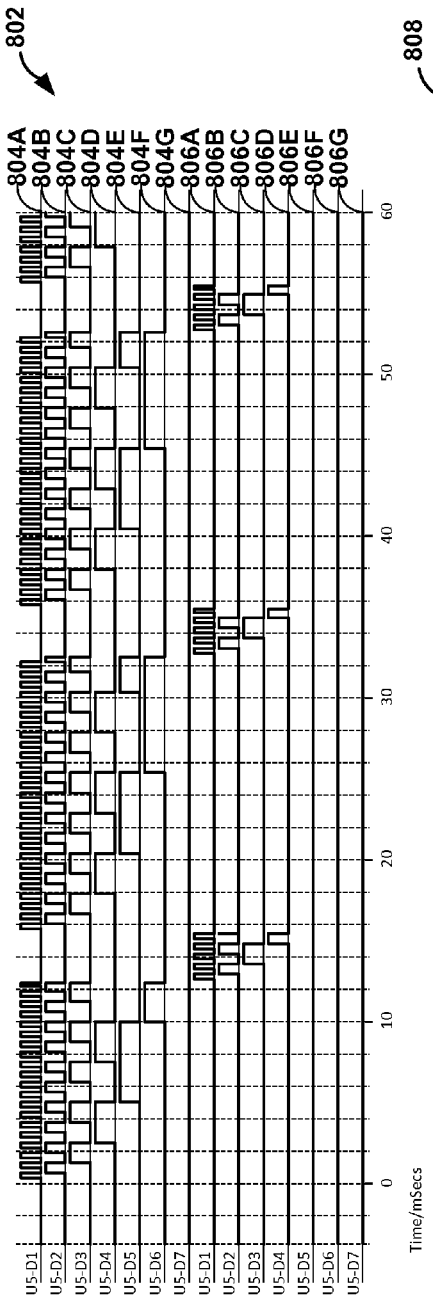


FIG. 8A

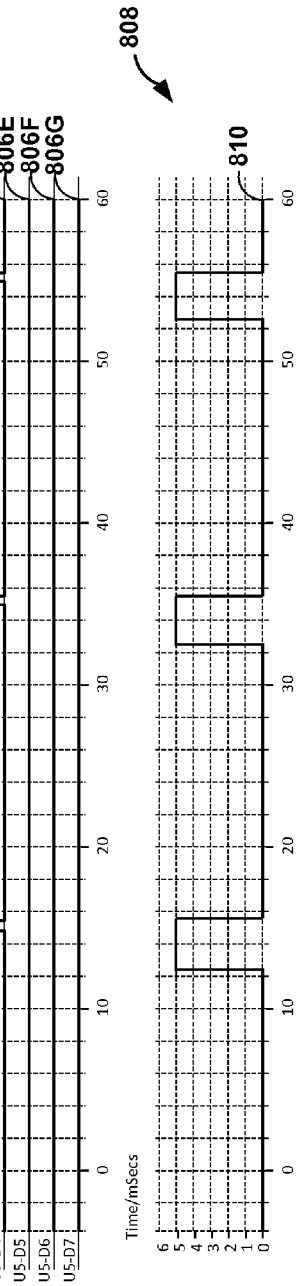


FIG. 8B

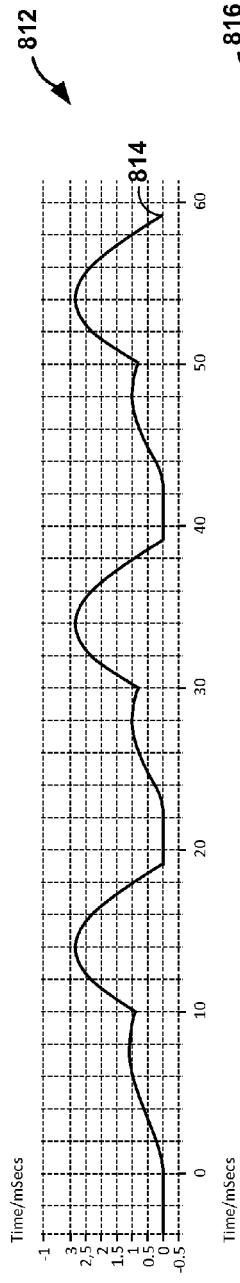


FIG. 8C

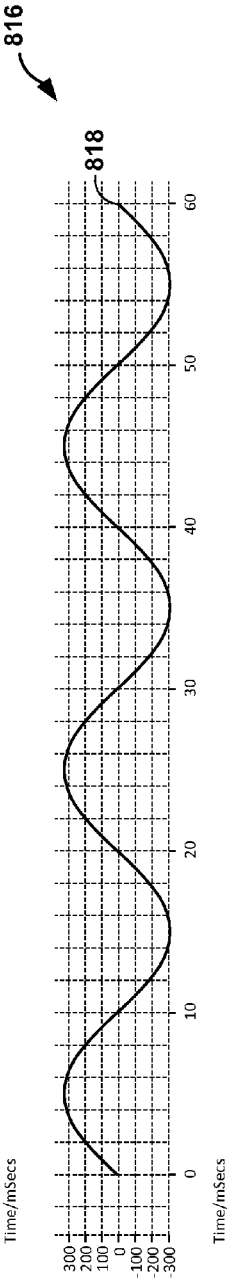


FIG. 8D

GROUND FAULT DETECTION

TECHNICAL FIELD

This disclosure relates to electrical grounding, and in particular, to techniques for determining whether or not a device is electrically grounded.

BACKGROUND

A ground connection, sometimes referred to as an earth connection, is an additional path for electrical current to return safely to ground from an electrical device without danger, e.g., in the event of a short circuit. Without a ground connection, an electrical device (such as an electronic device, circuit, electrical box, appliance, power tool, or any device that uses electricity) may become a danger to a person, as the person's body may function as the path to ground in the event of a short circuit. However, in some examples, an electrical device may not automatically detect the absence of a ground connection. Therefore, in some examples, there may be no evidence that an electrical device is lacking a ground connection.

SUMMARY

In general, the techniques described in this disclosure are related to determining whether or not an electrical system is connected to ground. For example, the output of a voltage divider included in a system may be connected to the reset input of a counter such that, if the output does not cross a threshold (and cause the counter to reset) before the counter reaches a value, it may be determined that the system is not connected to ground.

In one example, a method includes receiving, at an input of a system, an AC signal, rectifying the AC signal into a DC signal, and determining, based on a value of one or more counters in a detection logic whether or not the input is connected to ground.

In another example, a system includes an input configured to receive an AC signal, a rectifier configured to rectify the received AC signal into a DC signal, and a ground fault detector configured to determine, based on a value of one or more counters included in the ground fault detector whether or not the input is connected to ground.

In another example, a system includes means for receiving, at an input of a system, an AC signal, means for converting the AC signal into a DC signal, and means for determining whether or not the input is connected to ground. In this example, the means for determining comprises means for counting.

The details of one or more examples of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

BRIEF DESCRIPTION OF DRAWINGS

FIGS. **1**A-**1**B are block diagrams illustrating examples of a system with electrical supply lines, in accordance with one or more aspects of the present disclosure.

FIGS. **2**A-**2**B are circuit schematics illustrating examples of circuit for determining whether or not a system is connected to ground, in accordance with one or more aspects of the present disclosure.

FIG. **3** is a circuit schematic illustrating an example device that includes an example circuit for determining whether or not a system is connected to ground, in accordance with one or more aspects of the present disclosure.

FIG. **4** is a circuit schematic illustrating an example device that includes a ground fault detector configured to determine whether or not the system is connected to ground, in accordance with one or more aspects of the present disclosure.

FIGS. **5**A and **5**B are flowcharts illustrating example operations of a circuit for determining whether or not a device is connected to ground, in accordance with one or more aspects of the present disclosure

FIGS. **6**A-**6**D are graphs illustrating various signals of an example circuit for determining whether or not a system is connected to ground, in accordance with one or more techniques of this disclosure.

FIGS. **7**A-**7**D are graphs illustrating various signals of an example circuit for determining whether or not a system is connected to ground, in accordance with one or more techniques of this disclosure.

FIGS. **8**A-**8**D are graphs illustrating various signals of an example circuit for determining whether or not a system is connected to ground, in accordance with one or more techniques of this disclosure.

DETAILED DESCRIPTION

It may be desirable to determine whether or not an electrical system is connected to ground. For instance, to enable ground connectivity determination, an electrical system may include a ground fault detector configured to determine whether or not the electrical system is connected to ground.

In a typical AC powered electrical system, if the system ground connector is connected to ground, the voltage drop between the system ground connector and the system neutral connector may be approximately zero. However, in such a system, if the system ground connector is not connected to ground, the voltage drop between the system ground connector and the system neutral connector may be non-zero.

In accordance with one or more techniques of this disclosure, a ground fault detector may determine whether or not an electrical system is connected to ground by comparing a voltage level of a system ground connector to a voltage level of a system neutral power connector and/or a system phase power connector.

FIGS. **1**A-**1**B are block diagrams illustrating examples of system **2** with electrical supply lines, in accordance with one or more aspects of the present disclosure. As illustrated in FIGS. **1**A-**1**B, electrical system **2** may include device **4**, AC source **14**, and ground **16**.

System **2**, in some examples, may include AC source **14**. AC source **14** may be configured to provide electrical power in the form of alternating current (AC) to device **4**. Examples of AC source **4** include, but are not limited to, a power distribution grid, a power generator, a power inverter, and any other device capable of providing AC power. In some examples, AC source **14** may provide single phase power. In some examples, AC source **14** may provide multi-phase power.

System **2**, in some examples, may include device **4**. Device **4** may be configured to receive electrical power from AC source **14** and use the received power to perform one or more functions. Some examples of device **4** may include, but are not limited to, electric vehicle supply equipment (EVSE), battery chargers, welding machines, washing

machines, clothes drying machines, hair dryers, dishwashing machines, refrigerators/freezers, ovens, power tools, motors, or any other AC powered device. As shown in FIGS. **1**A-**1**B, device **4** may include ground fault detector **6**, live AC connector **8**, neutral AC connector **10**, and ground connector **12**. Live AC connector **8** may be connected to the live output of AC source **14** via live AC wire **9**, neutral AC connector **10** may be connected to the neutral output of AC source **14** via neutral AC wire **11**, and ground connector **12** may be connected to ground **16** via ground wire **13**.

In some examples, live AC connector **8**, neutral AC connector **10**, and ground connector **12** (collectively, the "power connectors") may be connected to their respective wires via a standard mains connector (e.g., a NEMA compliant grounded connector and/or international equivalents). In some examples, such as where device **4** is hardwired, the power connectors may each be separately connected to their respective wires.

In some examples, device **4** may include ground fault detector **6**. Ground fault detector **6** may be configured to determine whether or not device **4** is connected to ground. Specifically, ground fault detector **6** may be configured to determine whether or not ground connector **12** is connected to ground **16**.

In accordance with one or more techniques of this disclosure, ground fault detector **6** may determine whether or not ground connector **12** is connected to ground **16** by comparing the voltage level at ground connector **12** to the voltage level at neutral AC connector **10**. In some examples, ground fault detector **6** may determine that device **4** is ungrounded (i.e., that ground connector **12** is not connected to ground **16**) in response to determining that a difference between the voltage level at ground connector **12** and the voltage level at neutral AC connector **10** is greater than a threshold. In some examples, ground fault detector **6** may determine that device **4** is grounded (i.e., that ground connector **12** is connected to ground **16**) in response to determining that a difference between the voltage level at ground connector **12** and the voltage level at neutral AC connector **10** is less than a threshold.

As illustrated in the example of FIG. **1**B, device **4** may also include rectifier **20** and conditioning network **21**. In some examples, rectifier **20** may be configured to convert an AC signal into a DC signal. For instance, rectifier **20** may be configured to convert an AC signal received across live AC connector **8** and neutral AC connector **10** into a DC signal. In some examples, rectifier **20** may be a half-wave rectifier. In some examples, rectifier **20** may be a full-wave rectifier. In some examples, conditioning network **21** may be configured to perform one or more operations to condition the DC signal.

FIGS. **2**A-**2**B are circuit schematics illustrating examples of device **4** including an example circuit for determining whether or not device **4** is connected to ground, in accordance with one or more aspects of the present disclosure. As illustrated in FIGS. **2**A-**2**B, device **4** may include live AC connector **8**, neutral AC connector **10**, ground connector **12** (collectively, the "power connectors"), ground fault detector **6**, rectifier **20**, and conditioning network **21**.

In some examples, device **4** may include rectifier **20**. Rectifier **20** may be configured to convert an AC signal into a DC signal. For instance, rectifier **20** may convert an AC signal received across live AC connector **8** and neutral AC connector **10** into a DC signal output across positive DC node **40** and negative DC node **42**. As illustrated in the example of FIG. **2**A, rectifier **20** may be a bridge rectifier that includes a plurality of diodes.

In some examples, device **4** may include conditioning network **21** which may be configured to perform one or more operations to condition a signal. In some examples, conditioning network **21** may include voltage divider **22**. In some examples, conditioning network **21** may include voltage divider **22** and one or more additional components.

Voltage divider **22** may be configured scale a voltage signal based on a ratio between a first impedance level and a second impedance level. As illustrated in FIG. **2**A, voltage divider **22** may include first resistor **24** electrically positioned between positive DC node **40** and ground connector **12**, second resistor **26** electrically positioned between ground connector **12** and node **44**, and third resistor **28** electrically positioned between node **44** and negative DC node **42**. In some examples, voltage divider **22** may scale the voltage signal in accordance with equation (1), below, where V_{out} is the voltage signal output at node **44**, V_{in} is the voltage signal at positive DC node **40**, Z_2 is the impedance between node **44** and negative DC node **42**, and Z_1 is the impedance between node **44** and positive DC node **40**.

$$V_{out} = \frac{Z_2}{Z_1 + Z_2} V_{in} \quad (1)$$

In some examples, voltage divider **22** may be configured to have a ratio selected such that, during the time period corresponding to the negative half-wave of the AC signal, the output of voltage divider **22** exceeds a threshold if the input is connected to ground. For instance, the ratio may selected such that, during a time period corresponding to the negative half-wave of the AC signal, the voltage at node **44** is logic high if ground connector **12** is connected to ground. As one example, if the AC signal has an RMS voltage of 230 volts and the logic high threshold is 2.5 volts, resistor **24** and resistor **26** may have an impedance of 1 MΩ, and resistor **28** may have an impedance of 10 kΩ.

In some examples, device **4** may include ground fault detector **6**. Ground fault detector **6** may be configured to determine whether or not device **4** is connected to ground. Specifically, ground fault detector **6** may be configured to determine whether or not ground connector **12** is connected to ground **16**. As illustrated in FIG. **2**A, ground fault detector **6** may include oscillator **30**, and counter **32**.

In some examples, ground fault detector **6** may include counter **32**. Counter **32** may be configured to increment an output value (i.e., count) in response to receiving a signal at count input **46**. In some examples, counter **32** may increment the output value by adjusting the logic levels of outputs D**0**-D**6**. For instance, initially, the output value may be 0 (i.e., the signals at outputs D**0**-D**6** may be logic low), then, in response to receiving a logic high signal at count input **46**, counter **32** may increment the output value to 1 (i.e., the signal at output D**0** may be logic high and the signals at outputs D**1**-D**6** may be logic low). Similarly, if a logic high signal is received by counter **32** when the output value is 127 (i.e., the signals at outputs D**0**-D**5** may be logic high and the signal at output D**6** may be logic low), counter **32** may increment the output value to 128 (i.e., the signals at outputs D**0**-D**5** may be logic low and the signal at output D**6** may be logic high). Counter **32** may also be configured to reset the output value in response to receiving a signal at reset input **48**. For instance, if a logic high signal is received at reset input **48** when the output value is 127, counter **32** may reset the output value to 0. In some examples, if the voltage level of a signal is greater than one-half of the difference between

the voltage level at $+V_{cc}$ **34** and $-V_{cc}$ **36**, counter **32** may determine that the signal is logic high. In some examples, if the voltage level of a signal is less than one-half of the difference between the voltage level at $+V_{cc}$ **34** and $-V_{cc}$ **36**, counter **32** may determine that the signal is logic low.

In some examples, ground fault detector **6** may include oscillator **30**. Oscillator **30** may be configured to output a clock signal at a frequency. In some examples, the frequency of the clock signal output by oscillator **30** may be based on the frequency of the AC signal received across live AC connector **8** and neutral AC connector **10**, and a bit depth of counter **32**. In some examples, the frequency of the clock signal output by oscillator **30** may be determined in accordance with equation (2), below, where n is a number of bits less than or equal to the bit depth of the output value of counter **32**, f_{AC} is the frequency of the AC signal received across live AC connector **8** and neutral AC connector **10**, and f_{clock} is the frequency of the clock signal output by oscillator **30**.

$$f_{clock} = \frac{2^n}{2} f_{AC} \tag{2}$$

For example, if the frequency of the AC signal received across live AC connector **8** and neutral AC connector **10** is 50 Hz and the bit depth of the output of counter **30** is less than or equal to 8 bits (i.e., 256 steps), the frequency of the clock signal output by oscillator **30** may be 6400 Hz.

In operation, device **4** may receive an AC signal across live AC connector **8** and neutral AC connector **10**. In some examples, the AC signal may be a mains voltage signal (e.g., ~120 volts RMS @ 60 Hz in the United States, and 230 volts RMS @ 50 Hz in Germany).

Rectifier **20** may convert the received AC signal into a DC signal. In some examples, rectifier **20** may convert the received AC signal into a DC signal by allowing current to flow from live AC connector **8** to positive DC node **40** during the positive half-wave of the AC signal and by allowing current to flow from live AC connector **8** to negative DC node **42** during the negative half-wave of the AC signal. Similarly, rectifier **20** may allow current to flow from negative DC node **42** to neutral AC connector **10** during the positive half-wave of the AC signal and by allowing current to flow from positive DC node **40** to neutral AC connector **10** during the negative half-wave of the AC signal.

During the negative half-wave of the AC signal, the voltage level at node **44** may depend on whether or not ground connector **12** is connected to ground. For instance, if ground connector **12** is connected to ground, the voltage across resistor **24** will be approximately zero because the voltage at neutral AC connector **10** should be approximately equal to the voltage at ground connector **12**. As a result, during the negative half-wave of the AC signal, the output of voltage divider **22** may be determined approximately in accordance with equation (1 a), below, where V_{44} is the voltage at node **44**, Z_{28} is the impedance of resistor **28**, Z_{26} is the impedance of resistor **26**, V_{40} is the voltage at positive DC node **40**, and V_{42} is the voltage at negative DC node **42**.

$$V_{44} = \frac{Z_{28}}{Z_{26} + Z_{28}} (V_{40} - V_{42}) \tag{1a}$$

For example, if resistor **24** and resistor **26** each have an impedance of 1 MΩ, resistor **28** has an impedance of 10 kΩ, and the voltage across positive DC node **40** and negative DC node **42** is 252.5 volts, the voltage at node **44** may be 2.5 volts. Therefore, if the voltage across live AC connector **8** and neutral AC connector **10** AC signal has a frequency of 50 Hz and an RMS voltage of 230 volts (i.e., a peak voltage of ~325 volts), the voltage at node **44** will exceed 2.5 volts within 20 ms if ground connector **12** is connected to ground. In other words, if ground connector **12** is connected to ground, the voltage at node **44** will exceed a threshold value within a threshold period of time.

However, if ground connector **12** is not connected to ground, the voltage across resistor **24** may be non-zero. As a result, the output of voltage divider **22** may be different when ground connector **12** is not connected to ground then when ground connector **12** is connected to ground. If the voltage drop across resistor **24** (i.e., the potential difference between ground connector **12** and neutral AC connector **10**) becomes large enough, the voltage at node **44** may not reach the threshold value within a threshold period of time.

Oscillator **30** may output a clock signal that causes counter **32** to count (i.e., to increment the output value of counter **32**). As discussed above, the frequency at which oscillator **30** may cause counter **32** to count may be based on the frequency of the AC signal and a bit depth of counter **32**. In the example of FIG. **2**A, counter **32** may have a bit depth of 8 (i.e., counter **32** may be capable of counting from 0 to 255) and the AC signal may have a frequency of 50 Hz. Therefore, in the example of FIG. **2**A, in accordance with equation (2), oscillator **30** may cause counter **32** to increment its output value at a rate of 6400 Hz, or every 156.25 μs. At such a frequency, when starting from zero, the output value of counter **32** will reach 128 after 20 ms of counting. Additionally, as discussed above, in response to receiving a logic high signal at reset **48**, counter **32** may reset its output value to zero.

In accordance with one or more techniques of this disclosure, ground fault detector **6** may determine whether or not ground connector **12** is connected to ground based on the output value of counter **32**. For example, ground fault detector **6** may determine that ground connector **12** is connected to ground in response to determining that counter **32** has not reached a value. As another example, ground fault detector **6** may determine that ground connector **12** is not connected to ground in response to determining that counter **32** has reached a threshold value.

In the example of FIG. **2**A, the threshold value may be 128. As discussed above, counter **32** may determine that a signal greater than one-half of the difference between $+V_{CC}$ **34** and $-V_{CC}$ **36** is a logic high signal. As such, if the difference between $+V_{CC}$ **34** and $-V_{CC}$ **36** is 5 volts, counter **32** may reset its output value to zero in response to the voltage at node **44** becoming greater than 2.5 volts. Therefore, if resistor **24** and resistor **26** each have an impedance of 1 MΩ, resistor **28** has an impedance of 10 kΩ, and the voltage across live AC connector **8** and neutral AC connector **10** (i.e., the AC signal) has a frequency of 50 Hz and an RMS voltage of 230 volts, the voltage at node **44** will reach at least 2.5 volts, and thereby cause counter **32** to reset its output value, prior to the output value of counter **32** reaching 128 if ground connector **12** is connected to ground. However, if ground connector **12** is not connected to ground, the output value of counter **32** may reach 128 prior to the voltage at node **44** reaches 2.5 volts. In some examples, the voltage at node **44** may never reach 2.5 volts when ground

connecter **12** is not connected to ground. In this way, ground fault detector **6** may determine whether or not device **4** is grounded

In some examples, ground fault detector **6** may output a signal that indicates whether or not device **4** is grounded. In some examples, ground fault detector **6** may output the signal at ground detected output **38**. In some examples, such as in the example of FIG. **2**A, the pin representing the eighth bit of counter **32** (i.e., "D7") may be connected to ground detected output **38**.

In some examples, in response to receiving a signal at ground detected connector **38** that indicates that device **4** is not grounded, device **4** may not perform one or more functions. For example, if device **4** includes EVSE configured to charge an electric vehicle, in response to determining that device **4** is not grounded, device **4** may prevent the EVSE from supplying power to the electric vehicle. In this way, device **4** may mitigate the risk of electric shock due to a disconnected ground connection.

As illustrated in the example of FIG. **2**B, in some examples device **4** may not include some of the components illustrated in FIG. **2**A and/or may include components different than those illustrated in FIG. **2**A. For example, as illustrated in the example of FIG. **2**B, rectifier **20** of device **4** may be a half-wave rectifier. In such examples, device **4** may not include resistor **24**. In this way, device **4** may determine whether or not device **4** is connected to ground with fewer parts than illustrated in FIG. **2**A. Also in this way, device **4** may determine whether or not device **4** is connected to ground with a reduced power consumption than the example illustrated in FIG. **2**A.

FIG. **3** is a circuit schematic illustrating device **4** including an another example circuit for determining whether or not device **4** is connected to ground, in accordance with one or more aspects of the present disclosure. As illustrated in FIG. **3**, device **4** may include live AC connector **8**, neutral AC connector **10**, ground connector **12** (collectively, the "power connectors"), ground fault detector **6**, rectifier **20**, conditioning network **21**, and switch **55**. The features of live AC connector **8**, neutral AC connector **10**, ground connector **12**, rectifier **20**, and voltage divider **22** are described above with reference to FIG. **2**A.

In some examples, device **4** may include conditioning network **21** which may be configured to perform one or more operations to condition a signal. As illustrated in FIG. **3**, conditioning network **21** may include voltage divider **22**. The features of voltage divider **22** are described above with reference to FIG. **2**A.

In some examples, device **4** may include ground fault detector **6** which may be configured to determine whether or not device **4** is connected to ground. As illustrated in FIG. **3**, ground fault detector **6** may include oscillator **30**, oscillator **31**, counter **32**, counter **33**, comparator **58**, comparator **59**, limiter **52**, inverter **56**, and logic gate **60**. The features of oscillator **30**, and counter **32** are described above with reference to FIG. **2**A.

In some examples, ground fault detector **6** may include counter **33**. Counter **33** may be configured similarly to counter **32**. For example, counter **33** may be configured to increment an output value (i.e., count) in response to receiving a signal at count input **47**. As another example, counter **33** may also be configured to reset the output value in response to receiving a signal at reset input **49**.

In some examples, ground fault detector **6** may include comparator **58** and/or comparator **59** (collectively, the "comparators"). The comparators may be configured to receive a plurality of inputs and determine an output. For instance, comparator **58** may be configured to output a signal indicating whether or not the output value of counter **32** has or has not reached a threshold value. Similarly, comparator **59** may be configured to output a signal indicating whether or not the output value of counter **33** has or has not reached a threshold value. In some examples, the threshold values used by the comparators may be based on the frequency of the AC signal received across live AC connector **8** and neutral AC connector **10**.

In some examples, ground fault detector **6** may include limiter **52**. Limiter **52** may be configured to limit a voltage signal to within a threshold. In some examples, limiter **52** may be configured to receive a voltage signal from node **44**, limit the voltage signal such that it is within a threshold, and provide the thresholded voltage signal to counter **32** and inverter **56**. In this way, limiter **52** may protect one or more components from overvoltage (e.g., counter **32**, counter **33**, and inverter **56**).

In some examples, ground fault detector **6** may include inverter **56**. Inverter **56** may be configured to invert a voltage signal and/or a logic signal. For example, in response to receiving a logic high signal (e.g., a signal greater than one-half of the difference between $+V_{cc}$ **34** and $-V_{cc}$ **36**) from node **44** via limiter **52**, inverter **56** may provide a logic low signal (e.g., a signal less than one-half of the difference between $+V_{cc}$ **34** and $-V_{cc}$ **36**) to counter **33**. As another example, in response to receiving a logic low signal from node **44** via limiter **52**, inverter **56** may provide a logic high signal to counter **33**. In some examples, such as the example of FIG. **3**, the presence of inverter **56** may cause counter **33** to receive a reset signal when counter **32** is not receiving a reset signal, and may cause counter **33** to not receive a reset signal when counter **32** is receiving a reset signal.

In some examples, ground fault detector **6** may include logic gate **60**. Logic gate **60** may be configured to output a signal based on the logical state of two or more input signals. In some examples, logic gate **60** may be an OR gate configured to output a logic high signal if any of the input signals are logic high. In some examples, a first input of logic gate **60** may be the output of comparator **58** and a second input of logic gate **60** may be the output of comparator **59**.

In some examples, device **4** may include switch **55**. Switch **55** may be configured to conduct or not conduct based on an input signal. For example, switch **55** may conduct in response to receiving a signal at enable **54** that is greater than a threshold. As another example, switch **55** may not conduct in response to receiving a signal at enable **54** that is less than a threshold. Examples of switch **55** may include transistors, relay switches, and the like.

As discussed above with reference to FIG. **2**A, in operation, device **4** may receive an AC signal across live AC connector **8** and neutral AC connector **10**, rectifier **20** may convert the received AC signal into a DC signal, and oscillator **30** may output a clock signal that causes counter **32** and/or counter **33** to count. In some examples, as illustrated in FIG. **3**, device **4** may include a second oscillator **31** which may output a clock signal that causes counter **33** to count. In some examples oscillator **31** may output a clock signal similar to the clock signal output by oscillator **30** (e.g., similar frequency, similar duty cycle, etc. . . .). In some examples oscillator **31** may output a clock signal different than the clock signal output by oscillator **30** (e.g., different frequency, different duty cycle, etc. . . .).

Additionally, as discussed above with reference to FIG. **2**A, ground fault detector **6** may determine whether or not ground connector **12** is connected to ground based on the

output value of counter **32**. For instance, ground fault detector **6** may determine that ground connector **12** is not connected to ground if the output value of counter **32** reaches a threshold value prior to counter **32** receiving a reset signal (i.e., a logic high signal at reset input **48**). In accordance with one or more techniques of this disclosure, ground fault detector **6** may additionally or alternatively determine whether or not ground connector **12** is connected to ground based on the output value of counter **33**. For example, ground fault detector **6** may determine that ground connector **12** is not connected to ground if the output value of counter **33** does not reach a threshold value prior to counter **33** receiving a reset signal (i.e., a logic high signal at reset input **49**). In other words, ground fault detector **6** may determine that ground connector **12** is not connected to ground if the voltage level at node **44** does not remain at the logic high level for a long enough period of time.

In some examples, device **4** may be connected to ground if a ground wire is connected to both ground (e.g., a grounding pin) and ground connector **12** of device **4**. In some examples, if the output value of counter **32** reaches a first threshold value, ground fault detector **6** may determine that device **4** is not connected to ground within a first distance of device **4**. Device **4** may be connected to ground within the first distance if a ground wire is connected to ground connector **12** and the ground wire is either longer than the first distance, or the ground wire is actually connected to ground. For instance, if the output value of counter **32** reaches the first threshold value, ground fault detector **6** may determine that device **4** is not connected to ground within 100 or more meters from device **4**. Some example scenarios that may detected by counter **32** are where ground connector **12** is not connected to anything, and/or where ground connector **12** is connected to a ground wire, but the ground wire itself is not connected to ground and is shorter than the first distance (e.g., the result of an improper installation or a break in the ground wire).

In some examples, if the output value of counter **33** does not reach a second threshold value, ground fault detector **6** may determine that device **4** is not connected to ground within a second distance of device **4**. Device **4** may be connected to ground within the second distance if a ground wire is connected to ground connector **12** and the ground wire is either longer than the second distance, or the ground wire is actually connected to ground. For instance, if the output value of counter **33** does not reach the second threshold value, ground fault detector **6** may determine that device **4** is not connected to ground within, for instance, 200 meters of device **4**. Some example scenarios that may detected by counter **32** are where ground connector **12** is connected to a ground wire, but the ground wire itself is not connected to ground and is shorter than the second distance (e.g., the result of an improper installation or a break in the ground wire).

In some examples, the distance(s) at which an unconnected ground may be detected may be based on the relative values of resistor **24**, resistor **26**, and resistor **28**. For instance, if resistor **24** and resistor **26** each have an impedance of 1 MΩ, resistor **28** has an impedance of 10 kΩ, and the voltage across live AC connector **8** and neutral AC connector **10** AC signal has a frequency of 50 Hz and an RMS voltage of 230 volts, ground fault detector **6** may determine whether or not device **4** is grounded if ground connector **12** is connected to nothing, or if ground connector **12** is connected to a wire less than 200 meters that is not itself connected to ground (assuming that the wire has an average wire-earth capacity of 40 pF/m). However, if the values of resistor **24**, resistor **26**, and resistor **28** are decreased, the detection distance may also be increased because the decrease compensates for the capacitive coupling of the ground wire.

In some examples, ground fault detector **6** may be configured to continuously determine whether or not device **4** is grounded. In some examples, ground fault detector **6** may be configured to intermittently determine whether or not device **4** is grounded. For instance, by outputting a signal at enable **54**, device **4** and/or ground fault detector **6** may cause ground fault detector **6** to determine whether or not device **4** is grounded. In this way, device **4** and/or ground fault detector **6** may reduce the amount of power consumed by device **4**.

FIG. **4** is a circuit schematic illustrating an example device **4** including a ground fault detector configured to determine whether or not device **4** is connected to ground, in accordance with one or more aspects of the present disclosure. As discussed above, device **4** may be configured to receive electrical power from an AC source, such as AC source **14** of FIGS. **1**A-**1**B, and use the received power to perform one or more functions. In the example of FIG. **4**, device **4** may include power factor corrector (PFC) **5**. As illustrated in FIG. **4**, PFC **5** may include live AC connector **8**, neutral AC connector **10**, ground connector **12** (collectively, the "power connectors"), electromagnetic compatibility (EMC) filter **64**, rectifier **20**, in-rush current limiter **90**, controller **86**, and ground detection input **88**. In some examples, PFC **5** may also include variable resistor **66**, switch **68**, resistor **70**, resistor **72**, inductor **74**, diode **76**, switch **78**, resistor **80**, resistor **82**, and current sensor **84**.

In some examples, PFC **5** may include ground detection input **88**. Ground detection input **88** may include a conditioning network, such as conditioning network **21**, the details of which are described above with reference to FIG. **2**A. In some examples, PFC **5** may include controller **86**. Controller **86** may be configured to perform a variety of functions to enable power factor correction.

In accordance with one or more techniques of this disclosure, controller **86** may include a ground fault detector, such as ground fault detector **6** of FIGS. **1**-**3**, which may be configured to determine whether or not device **4** is connected to ground. In some examples, ground fault detector **6** may be configured to output a signal to ground detected output **38**. As discussed above, in some examples, in response to receiving a signal at ground detected output **38** that indicates that device **4** is not grounded, device **4** may not perform one or more functions. For example, if PFC **5** is used to supply power to another device (which may be included in device **4**), the other device may be configured to not perform one or more functions in response to receiving the signal at ground detected output **38** that indicates that device **4** is not connected to ground. As another example, the other device may be configured to not perform one or more functions unless a signal is received at ground detected output **38** that indicates that device **4** is connected to ground.

FIGS. **5**A and **5**B are flowcharts illustrating example operations of a circuit for determining whether or not a device is connected to ground, in accordance with one or more aspects of the present disclosure. For purposes of illustration, the techniques of FIGS. **5**A and **5**B are described within the context of device **4** and ground fault detector **6** of FIGS. **1**-**3** although devices and ground fault detectors having configurations different than that of device **4** and ground fault detector **6** may perform the techniques of FIGS. **5**A and **5**B.

In accordance with one or more techniques of this disclosure, device **4**, may receive, at an input, an AC signal (**504**). For instance, device **4** may receive an AC signal across live AC connector **8** and neutral AC connector **10**. Device **4** may rectify the AC signal into a DC signal (**506**). For instance, rectifier **20** of device **4** may rectify the AC signal into a DC signal. Device **4** may determine whether or not the input is connected to ground (**508**). For instance, ground fault detector **6** may determine whether or not device **4** is grounded. Ground fault detector **6** may increment a counter, such as counter **32**, at a frequency determined based on the frequency of the AC signal and a number of steps of the counter (**510**). In response to determining that the output of a voltage divider, such as voltage divider **22**, is greater than a threshold, ground fault detector **6** may reset the counter (**512**). In response to determining that the counter has reached a threshold value, ground fault detector **6** may determine that the device is not grounded (**514**).

FIGS. **6**A-**6**D are graphs illustrating various signals of an example circuit for determining whether or not a device is connected to ground, in accordance with one or more techniques of this disclosure. As illustrated in FIG. **6**A, graph **602** may include a horizontal axis representing time, plots **604**A-**604**G illustrating a first set of digital signals, and plots **606**A-**606**G illustrating a second set of digital signals. In some examples, the first set of digital signals may represent the outputs of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is connected to ground. In some examples, the second set of digital signals may represent the outputs of counter **33** of device **4** of FIG. **3** where device **4** is connected to ground.

As illustrated in FIG. **6**B, graph **608** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **610** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at a buffer connected to node **44** and reset input **48** of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is connected to ground.

As illustrated in FIG. **6**C, graph **612** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **614** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at node **44** of device **4** of FIG. **2**A and FIG. **3** where device **4** is connected to ground.

As illustrated in FIG. **6**D, graph **616** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **618** representing a voltage signal. In some examples, the voltage signal may represent the voltage signal received across live AC connector **8** and neutral AC connector **10** of device **4** of FIG. **2**A and FIG. **3** where device **4** is connected to ground.

In accordance with one or more techniques of this disclosure, a ground fault detector included in a device may determine that the device is not connected to ground if the output value of a first counter reaches a threshold value and/or if the output value of a second counter does not reach a threshold value. In some examples, a ground fault detector included in a device with signals corresponding to the signals of FIGS. **6**A-**6**D may determine that the device is connected to ground because the digital signal illustrated by plot **604**G does not become logic high prior to the signal illustrated by plot **610** becoming logic high (i.e., the output value of counter **32** does not reach 64). In some examples, a ground fault detector included in a device with signals corresponding to the signals of FIGS. **6**A-**6**D may determine that the device is connected to ground because the digital signals illustrated by plots **606**A, **606**C, and **606**D contemporaneously become logic high while signal illustrated by plot **610** is logic high (i.e., the output value of counter **33** does reach 13).

FIGS. **7**A-**7**D are graphs illustrating various signals of an example circuit for determining whether or not a device is connected to ground, in accordance with one or more techniques of this disclosure. As illustrated in FIG. **7**A, graph **702** may include a horizontal axis representing time, plots **704**A-**704**G illustrating a first set of digital signals, and plots **706**A-**706**G illustrating a second set of digital signals. In some examples, the first set of digital signals may represent the outputs of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a first distance of device **4**. In some examples, the second set of digital signals may represent the outputs of counter **33** of device **4** of FIG. **3** where device **4** is not connected to ground within a first distance of device **4**.

As illustrated in FIG. **7**B, graph **708** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **710** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at a buffer connected to node **44** and reset input **48** of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a first distance of device **4**.

As illustrated in FIG. **7**C, graph **712** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **714** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at node **44** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a first distance of device **4**.

As illustrated in FIG. **7**D, graph **716** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **718** representing a voltage signal. In some examples, the voltage signal may represent the voltage signal received across live AC connector **8** and neutral AC connector **10** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a first distance of device **4**.

In accordance with one or more techniques of this disclosure, a ground fault detector included in a device may determine that the device is not connected to ground if the output value of a first counter reaches a threshold value and/or if the output value of a second counter does not reach a threshold value. In some examples, a ground fault detector included in a device with signals corresponding to the signals of FIGS. **7**A-**7**D may determine that the device is not connected to ground because the digital signal illustrated by plot **704**G does become logic high prior to the signal illustrated by plot **710** becoming logic high (i.e., the output value of counter **32** does reach 64).

FIGS. **8**A-**8**D are graphs illustrating various signals of an example circuit for determining whether or not a device is connected to ground, in accordance with one or more techniques of this disclosure. As illustrated in FIG. **8**A, graph **802** may include a horizontal axis representing time, plots **804**A-**804**G illustrating a first set of digital signals, and plots **806**A-**806**G illustrating a second set of digital signals. In some examples, the first set of digital signals may represent the outputs of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a second distance of device **4**. In some examples, the second set of digital signals may represent the outputs of counter **33** of device **4** of FIG. **3** where device **4** is not connected to ground within a second distance of device **4**.

As illustrated in FIG. **8**B, graph **808** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **810** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at a buffer connected to node **44** and reset input **48** of counter **32** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a second distance of device **4**.

As illustrated in FIG. **8**C, graph **812** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **814** representing a voltage signal. In some examples, the voltage signal may represent the voltage level at node **44** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a second distance of device **4**.

As illustrated in FIG. **8**D, graph **816** may include a horizontal axis representing time, a vertical axis representing voltage, and plot **818** representing a voltage signal. In some examples, the voltage signal may represent the voltage signal received across live AC connector **8** and neutral AC connector **10** of device **4** of FIG. **2**A and FIG. **3** where device **4** is not connected to ground within a second distance of device **4**.

In accordance with one or more techniques of this disclosure, a ground fault detector included in a device may determine that the device is not connected to ground if the output value of a first counter reaches a threshold value and/or if the output value of a second counter does not reach a threshold value. In some examples, a ground fault detector included in a device with signals corresponding to the signals of FIGS. **8**A-**8**D may determine that the device is connected to ground because the digital signals illustrated by plots **806**A, **806**C, and **806**D do not contemporaneously become logic high while signal illustrated by plot **810** is logic high (i.e., the output value of counter **33** does not reach 13).

Example 1

A method comprising: receiving, at an input of a system, an AC signal; rectifying the AC signal into a DC signal; and determining, based on a value of one or more counters in a detection logic, whether or not the input is connected to ground.

Example 2

The method of example 1, wherein the determining whether or not the input is connected to ground comprises: incrementing a first counter of the one or more counters at a frequency determined based on the frequency of the AC signal and a number of steps of the first counter; in response to determining that the output of a conditioning network is greater than a threshold, resetting the first counter; and in response to determining that the first counter reached a value, determining that the input is not connected to ground.

Example 3

The method of any combination of examples 1-2, wherein the conditioning network includes a voltage divider configured to have a ratio selected such that, during the time period corresponding to the negative half-wave of the AC signal, the output of the voltage divider exceeds the threshold if the input is connected to ground.

Example 4

The method of any combination of examples 1-3, wherein the value is a first value, and wherein determining whether or not the input is connected to ground further comprises: in response to determining that the output of the voltage divider is greater than the threshold, incrementing a second counter of the one or more counters; in response to determining that the output of a voltage divider is less than the threshold, resetting the second counter; and in response to determining that, prior to being reset, the second counter did not reach the second value, determining that the input is not connected to ground.

Example 5

The method of any combination of examples 1-4, wherein determining whether or not the input is connected to ground comprises determining whether or not the input is connected to ground within a distance of the system, wherein the input is not connected to ground within a first portion of the distance if the first counter reaches the first value, wherein the input is not connected to ground within a second portion of the distance if the second counter does not reaches the second value.

Example 6

The method of any combination of examples 1-5, wherein the frequency at which the first counter is incremented is determined approximately in accordance with the following equation:

$$f_{counter} = f_{AC} * \frac{2^n}{2},$$

wherein $f_{counter}$ is the frequency at which the first counter is incremented, f_{AC} is the frequency of the AC signal, and n is a number of bits of the first counter.

Example 7

The method of any combination of examples 1-6, wherein determining whether or not the input is connected to ground comprises determining whether or not the input is connected to ground in response to receiving an enable signal.

Example 8

The method of any combination of examples 1-7, wherein determining whether or not the input is connected to ground comprises determining whether or not the input is connected to ground within a distance of the system, and wherein the distance is based on the values of the components of the conditioning network.

Example 9

The method of any combination of examples 1-8, wherein the system comprises electric vehicle supply equipment (EVSE), the method further comprising: in response to determining that the input is not connected to ground, preventing the EVSE from supplying power to an electric vehicle.

Example 10

A system comprising: an input configured to receive an AC signal; a rectifier configured to rectify the received AC signal into a DC signal; and a ground fault detector config-

ured to determine, based on a value of one or more counters included in the ground fault detector, whether or not the input is connected to ground.

Example 11

The system of example 10, wherein a first counter of the one or more counters is configured to increment at a frequency determined based on the frequency of the AC signal and the number of steps of the first counter, the system further comprising: a conditioning network, wherein the counter is configured to reset in response to the voltage level at the output of the conditioning network exceeding a threshold; and an output configured to indicate whether or not the input is connected to ground, wherein the output is configured to indicate that the input is not connected to ground in response to the counter reaching a value.

Example 12

The system of any combination of examples 10-11, wherein the conditioning network includes a voltage divider, and wherein the voltage divider comprises: a first resistor connected to a positive output of the rectifier and a ground connector of the input; a second resistor connected to the ground connector of the input and a node, wherein the node is the output of the voltage divider; and a third resistor connected to a negative output of the rectifier and the node, wherein the values of the resistors are selected such that, during the time period corresponding to the negative half-wave of the AC signal, the output of the voltage divider exceeds the threshold if the input is connected to ground.

Example 13

The system of any combination of examples 10-12, wherein the value is a first value, wherein a second counter of the one or more counters is configured to increment, wherein the second counter is configured to reset in response to the voltage level at the output of the conditioning network falls below the threshold, and wherein the output is configured to indicate that the input is not connected to ground in response to the second counter not reaching a second value.

Example 14

The system of any combination of examples 10-13, wherein the ground fault detector is configured to determine whether or not the input is connected to ground within a distance of the ground fault detector, wherein the first counter is configured to determine whether or not the input is connected to ground within a first portion of the distance, wherein the second counter is configured to determine whether or not the input is connected to ground within a second portion of the distance.

Example 15

The system of any combination of examples 10-14, wherein the frequency at which the first counter is incremented is determined approximately in accordance with the following equation:

$$f_{counter} = f_{AC} * \frac{2^n}{2},$$

wherein $f_{counter}$ is the frequency at which the first counter is incremented, f_{AC} is the frequency of the AC signal, and n is a number of bits of the first counter.

Example 16

The system of any combination of examples 10-15, further comprising: an enable input configured to enable the ground fault detector in response to receiving an enable signal.

Example 17

The system of any combination of examples 10-16, wherein the ground fault detector is configured to determine whether or not the input is connected to ground within a distance of the system, and wherein the distance is based on the values of the components of the conditioning network.

Example 18

The system of any combination of examples 10-17, wherein the system comprises electric vehicle supply equipment (EVSE), wherein in response to the value of a counter of the one or more counters indicating that the input is not connected to ground, the EVSE is prevented from supplying power to an electric vehicle.

Example 19

A system comprising: means for receiving, at an input of a system, an AC signal; means for converting the AC signal into a DC signal; and means for determining whether or not the input is connected to ground, wherein the means for determining comprise means for counting.

Example 20

The system of example 19, wherein the means for determining further comprise: means for resetting the means for counting in response to determining that the output of a conditioning network is greater than a threshold, wherein the means for determining whether or not the input is connected to ground are configured to determine that the input is not connected to ground if the means for counting reach a value.

Example 21

The system of example 20, wherein the means for counting are first means for counting, wherein the value is a first value, wherein the means for determining whether or not the input is connected to ground further comprise: second means for counting; means for resetting the second means for counting in response to determining that the output of the conditioning network is less than the threshold, wherein the means for determining whether or not the input is connected to ground are configured to determine that the input is not connected to ground if the second means for counting do not reach a second value.

Example 22

The system of any combination of examples 20-21, wherein the means for counting are configured to count at a frequency determined based on the frequency of the AC signal and a number of steps of the means for counting.

Example 23

The system of any combination of examples 20-22, wherein the means for determining whether or not the input is connected to ground are configured to determine whether or not the input is connected to ground in response to receiving an enable signal.

Example 24

The system of any combination of examples 20-23, further comprising means for performing any combination of the techniques of examples 1-9.

Various examples of the invention have been described. These and other examples are within the scope of the following claims.

The invention claimed is:

1. A method comprising:

receiving, at an input of a system, an AC signal;

rectifying the AC signal into a DC signal;

incrementing a first counter of one or more counters at a frequency determined based on the frequency of the AC signal and a number of steps of the first counter;

in response to determining that the output of a conditioning network is greater than a threshold, resetting the first counter; and

in response to determining that the first counter reached a value, determining that the input is not connected to ground.

2. The method of claim **1**, wherein the conditioning network includes a voltage divider configured to have a ratio selected such that, during the time period corresponding to the negative half-wave of the AC signal, the output of the voltage divider exceeds the threshold if the input is connected to ground.

3. The method of claim **1**, wherein the value is a first value, the method further comprising:

in response to determining that the output of the voltage divider is greater than the threshold, incrementing a second counter of the one or more counters;

in response to determining that the output of a voltage divider is less than the threshold, resetting the second counter; and

in response to determining that, prior to being reset, the second counter did not reach the second value, determining that the input is not connected to ground.

4. The method of claim **3**, wherein determining whether or not the input is connected to ground comprises determining whether or not the input is connected to ground within a distance of the system, wherein the input is not connected to ground within a first portion of the distance if the first counter reaches the first value, wherein the input is not connected to ground within a second portion of the distance if the second counter does not reaches the second value.

5. The method of claim **1**, wherein the frequency at which the first counter is incremented is determined approximately in accordance with the following equation:

$$f_{counter} = f_{AC} * \frac{2^n}{2},$$

wherein $f_{counter}$ is the frequency at which the first counter is incremented, f_{AC} is the frequency of the AC signal, and n is a number of bits of the first counter.

6. The method of claim **1**, further comprising:

determining whether or not the input is connected to ground in response to receiving an enable signal.

7. The method of claim **1**, further comprising:

determining whether or not the input is connected to ground within a distance of the system, and wherein the distance is based on the values of the components of the conditioning network.

8. The method of claim **1**, wherein the system comprises electric vehicle supply equipment (EVSE), the method further comprising:

in response to determining that the input is not connected to ground, preventing the EVSE from supplying power to an electric vehicle.

9. A system comprising:

an input configured to receive an AC signal;

a rectifier configured to rectify the received AC signal into a DC signal;

a conditioning network; and

a ground fault detector configured to determine, in response to determining that a first counter of one or more counters included in the ground fault detector reached a value, that the input is not connected to ground, wherein the first counter is configured to: increment at a frequency determined based on the frequency of the AC signal and a number of steps of the first counter, and reset in response to the voltage level at the output of the conditioning network exceeding a threshold.

10. The system of claim **9**, further comprising:

an output configured to indicate whether or not the input is connected to ground.

11. The system of claim **9**, wherein the conditioning network includes a voltage divider, and wherein the voltage divider comprises:

a first resistor connected to a positive output of the rectifier and a ground connector of the input;

a second resistor connected to the ground connector of the input and a node, wherein the node is the output of the voltage divider; and

a third resistor connected to a negative output of the rectifier and the node,

wherein the values of the resistors are selected such that, during the time period corresponding to the negative half-wave of the AC signal, the output of the voltage divider exceeds the threshold if the input is connected to ground.

12. The system of claim **9**, wherein the value is a first value, wherein a second counter of the one or more counters is configured to increment, wherein the second counter is configured to reset in response to the voltage level at the output of the conditioning network falls below the threshold, and wherein the ground fault detector is configured to determine that the input is not connected to ground in response to the second counter not reaching a second value.

13. The system of claim **12**, wherein the ground fault detector is configured to determine whether or not the input is connected to ground within a distance of the ground fault detector, wherein the first counter is configured to determine whether or not the input is connected to ground within a first portion of the distance, wherein the second counter is configured to determine whether or not the input is connected to ground within a second portion of the distance.

14. The system of claim **9**, wherein the frequency at which the first counter is incremented is determined approximately in accordance with the following equation:

$$f_{counter} = f_{AC} * \frac{2^n}{2},$$

wherein $f_{counter}$ is the frequency at which the first counter is incremented, f_{AC} is the frequency of the AC signal, and n is a number of bits of the first counter.

15. The system of claim **9**, further comprising:

an enable input configured to enable the ground fault detector in response to receiving an enable signal.

16. The system of claim **9**, wherein the ground fault detector is configured to determine whether or not the input is connected to ground within a distance of the system, and wherein the distance is based on the values of the components of the conditioning network.

17. The system of claim **9**, wherein the system comprises electric vehicle supply equipment (EVSE), wherein in response to the value of a counter of the one or more counters indicating that the input is not connected to ground, the EVSE is prevented from supplying power to an electric vehicle.

18. A system comprising:

means for receiving, at an input of a system, an AC signal;

means for converting the AC signal into a DC signal;

means for incrementing a first counter of one or more counters at a frequency determined based on the frequency of the AC signal and a number of steps of the first counter;

means for resetting the first counter in response to determining that the output of a conditioning network is greater than a threshold; and

means for determining that the input is not connected to ground in response to determining that the first counter reached a value.

19. The system of claim **18**, wherein the means for determining whether or not the input is connected to ground are configured to determine whether or not the input is connected to ground in response to receiving an enable signal.

20. The system of claim **18**, wherein the value is a first value, the system further comprising:

means for incrementing a second counter of the one or more counters in response to determining that the output of the voltage divider is greater than the threshold;

means for resetting the second counter in response to determining that the output of a voltage divider is less than the threshold; and

means for determining that the input is not connected to ground in response to determining that, prior to being reset, the second counter did not reach the second value.

21. The system of claim **18**, wherein the frequency at which the means for incrementing increment the first counter is determined approximately in accordance with the following equation:

$$f_{counter} = f_{AC} * \frac{2^n}{2},$$

wherein $f_{counter}$ is the frequency at which the first counter is incremented, f_{AC} is the frequency of the AC signal, and n is a number of bits of the first counter.

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